Training muscles and brains: being physically and cognitively active at early ages

Entrenando músculos y cerebros: ser físicamente activo para ser cognitivamente activo a edades tempranas

Irene Esteban-Cornejo, Francisco B. Ortega

PROFITH "PROmoting FITness and Health through physical activity" Research Group, Department of Physical Education and Sports, Faculty of Sport Sciences, University of Granada, Spain.

Introduction

Public health institutions recommend that children and adolescents should carry out at least 60 minutes of moderate-vigorous physical activity each day to achieve substantial health benefits[1]. There are numerous benefits associated to physical health; however, the potential effects of physical activity on cognition should be examined more extensively[2]. We work under the slogan of "training muscles and brains: be physically active to be cognitively active". Physical activity stimulates some factors involved in cerebral plasticity, such as the brain-derived neurotrophic factor (BDNF)[3]. Therefore, being physically active may have beneficial effects on brain development, which in turn may play a key role in the cognition of children and adolescents.

Cognición

Cognition, understood as the mental function involved in the in¬teriorisation of knowledge and comprehension, alludes both to the cognitive and academic aspect. In fact, the cognitive function (also known as the executive function or cognitive control), plays a key role in the academic performance of students. Specifically, the cognitive function includes 3 important aspects: cognitive inhibition, work memory and cognitive flexibility. Previous studies have demonstrated that, in particular, cognitive inhibition and work memory provide the foundations for developing academic abilities in children and adolescents[4]. The stages of childhood and adolescence are characterised by periods of significant brain plasticity, providing great opportunities for stimulating the cognitive function; furthermore, despite practically all the neurons we have over our entire lives being formed in the first 3 years of life, it is from 6-7 years, at the start of childhood, when the number of neuronal connections begins to increase considerably and progressively up to the age of 15-16 years, an age at which adolescents reveal greater rates of reduced physical activity[5-6]. Paradoxically, the moment the number of neuronal connections begins to fall corresponds to the mo¬ment in which adolescents reduce their levels of physical activity. Therefore, inactive adolescents may be losing an important stimulus in improving their cognitive performance.

Physical activity and cognition during childhood and adolescence

Various systematic reviews have brought to light the influence of physical activity in the cognition of children and adolescents[7-8]. However, there is currently controversy regarding the type, frequency, duration and intensity of physical activity required to achieve the greatest cognitive benefits. Some studies affirm that short periods of vigorous physical activity should be carried out, whilst others claim that at least 60 minutes of moderate-vigorous activity should be performed each day. Others focus on the type of physical activity (aerobic exercise *vs.* strength work), however, some studies indicate that it may have no cognitive benefit, or even that high levels of physical activity could lead to unexpected effects[7-9].

Just as when following a medical prospectus, a specific dose is administered to achieve an expected response; the same would occur

Correspondence: Irene Esteban Cornejo
E-mail: ireneesteban@ugr.es

with physical activity like a "pill" in relation to cognition. It is possible that intermediate levels of physical activity, in terms of minutes of daily activity, may entail greater cognitive benefits. Along this same line, a recent study indicates that maintaining a regularly active lifestyle may have greater cognitive-associated benefits compared to acquiring changing physical activity behaviour. In other words, being "too under active" at some ages and "too active" at other ages seems to be less effective (and may even have, to a certain extent, contrary effects), than maintaining a moderately active behaviour over the whole childhood and adolescence in achieving cognitive benefits[10]. Therefore, despite physical activity maybe being beneficial in all stages of life, early intervention could be important in improving and/or maintaining cognitive functions, as the earlier the start of physical activity practice, the greater the cognitive benefits may be.

Physical activity and cognition in the school context

The school context provides a unique opportunity to promote physical activity with Physical Education, break times, active rest times or active movements at school, which may contribute substantially to the increase in physical activity levels, in turn implying benefits on a cognitive level. It is important to call to action all educational institutions, given that, in an effort to increase the academic performance of student, there have been proposed solutions to dedicate more time to instrumental subjects, reducing or eliminating the time that students have to be active (see Physical Education). However, it is worth noting that there is no scientific evidence to prove that eliminating non-instrumental subjects such as Physical Education is related to enhanced academic performance[8]. In fact, empirical evidence suggests that peak levels of physical condition may have a positive effect on academic performance, whilst obesity may have negative repercussions on academic performance[11].

Mechanisms

Various mechanisms are involved in the effects of physical activity on the brain function from early ages up to adulthood. Physical activity may increase the formation of new neurones and concentrations of BDNF, increase the blood flow to the brain and the oxygen supply to it, as well as increasing synaptic plasticity[3,12]. This collection of physiological changes are related to: 1) attention; 2) processing information, storing and recovering information; as well as 3) mental concentration[4]. Therefore, these changes may lead to improvements in the cognitive and academic performance of young people.

Future orientations

Despite the abundance of knowledge about the effects of physical activity on the brain and on cognition, there are still a multitude of issues to resolve. From a practical point of view, there is little knowledge about how to design interventions based on physical exercise that optimise the effects of cognition and brain health. Issues regarding the context, mode, frequency, duration and intensity of the physical activity to achieve the greatest cognitive results should also be resolved in future research studies. From the ActiveBrains study[13] (http://profith.ugr.es/activebrains), a random trial with the main aim of examining the effects of an exercise programme on cognition, and the structure and function of the brain in overweight/obese children, we aim to contribute towards responding to these issues.

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